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Do thin, overweight and obese children have poorer development than their healthy-weight peers at the start of school? Findings from a South Australian data linkage study

Anna Pearce[a,b], Daniel Scalzi[a], John Lynch[a,c], Lisa G. Smithers[a,*]

[a] School of Public Health, University of Adelaide, Mail drop DX 650550, Adelaide 5005, Australia
[b] Population, Policy and Practice, UCL Institute of Child Health, 30 Guilford Street, London WC1N 1EH, United Kingdom
[c] School of Social & Community Medicine, University of Bristol, BS82BM, United Kingdom

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ABSTRACT

Little is known about the holistic development of children who are not healthy-weight when they start school, despite one fifth of preschool-aged children in high income countries being overweight or obese. Further to this, there is a paucity of research examining low body mass index (BMI) in contemporary high-income populations, although evidence from the developing world demonstrates a range of negative consequences in childhood and beyond. We investigated the development of 4–6 year old children who were thin, healthy-weight, overweight, or obese (as defined by BMI z-scores) across the five domains of the Australian Early Development Census (AEDC): Physical Health and Wellbeing, Social Competence, Emotional Maturity, Language and Cognitive Skills, and Communication Skills and General Knowledge. We used a linked dataset of South Australian routinely collected data, which included the AEDC, school enrollment data, and perinatal records ($n = 7533$). We found that the risk of developmental vulnerability among children who were thin did not differ from healthy-weight children, after adjusting for a range of perinatal and socio-economic characteristics. On the whole, overweight children also had similar outcomes as their healthy-weight peers, though they may have better Language and Cognitive skills (adjusted Risk Ratio [aRR] = 0.73 [95% CI 0.50–1.05]). Obese children were more likely to be vulnerable on the Physical Health and Wellbeing (2.20 [1.69, 2.87]) and Social Competence (1.31 [0.94, 1.83]) domains, and to be vulnerable on one or more domains (1.45 [1.18, 1.78]). We conclude that children who are obese in the first year of school may already be exhibiting some developmental vulnerabilities (relative to their healthy-weight peers), lending further support for strategies to promote healthy development of preschoolers.

1. Introduction

The transition into primary school is considered to be an important period in the life course. A child's ability to fully benefit from, and participate in, school life is dependent upon their physical, cognitive, and socio-emotional development (Janus et al., 2007; UNICEF & Britto, 2012). Every child has the right to be physically healthy, including being free from illness and possessing the fine and gross motor skills (such as the ability to hold a pencil and to move around independently) to allow them to engage in classroom activities. Other essential foundations for learning include cognitive abilities (such as knowledge of the alphabet, basic numeracy, and logic) and language skills (reading, speaking, and understanding). Socio-emotional behaviors including emotional regulation, attention, social relationships, and awareness, as well as attitudes (curiosity, persistence, creativity, and problem solving) are supportive of learning (Janus et al., 2007; UNICEF & Britto, 2012). These aspects of child development have been linked to later school achievement (Brinkman, Gregory, Harris, Hart, Blackmore, & Janus, 2013; Forget-Dubois et al., 2007; Oberle, Schonert-Reichl, Hertzman, & Zumbo, 2014) and subsequently to health, well-being, and social circumstances (such as employment status) in adulthood (Hertzman & Wiens, 1996; Law, 2009; Lynch & Smith, 2005).

There is recognition of the potential for early child development to improve health and well-being (Jolly, 2007), and supporting early

* Corresponding author at: School of Population Health, Mail drop DX 650550, University of Adelaide, 5005, Australia.
E-mail addresses: anna.pearce@ucl.ac.uk (A. Pearce), daniel.scalzi@adelaide.edu.au (D. Scalzi), john.lynch@adelaide.edu.au (J. Lynch), lisa.smithers@adelaide.edu.au (L.G. Smithers).

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child development is a priority of governments around the globe (Abbott et al., 2002; Allen, 2011; Australian Institute of Health and Welfare, 2011; Council of Australian Governments, 2009; Council of Ministers of Education, 2014; UNICEF, 2007). This has prompted the design of schemes such as the Australian Early Development Census (AEDC), which involves monitoring aspects of early child development that are relevant for understanding children's preparedness to learn at school and is indicative of later school performance (Brinkman et al., 2012; Janus et al., 2007).

All aspects of child development, including cognition, socio-emotional well-being, and motor skills, are dependent upon physical and nutritional well-being. The interdependence between different aspects of health and well-being (e.g., mental health and chronic disease) is increasingly acknowledged by researchers and policy makers alike (Australian Institute of Health and Welfare, 2012; Barnett et al., 2012; Department of Health and Department for Children Schools and Families, 2009). Yet in developed countries, little is known about the general development of children who are not of a healthy body mass index (BMI). This is despite dramatic increases in rates of overweight and obesity (Hardy et al., 2012; Wang et al., 2013); and a wealth of evidence from low- to middle-income countries on the detrimental impacts of impeded growth throughout infancy and childhood (Grantham-McGregor, Fernald, & Sethuraman, 1999a; Nyaradi, Li, Hickling, Foster, & Oddy, 2013).

1.1. Overweight, obesity and early childhood development

In recent decades, childhood overweight and obesity have increased dramatically in Australia (Booth, Wake, Armstrong, Chey, Hesketh, & Mathur, 2001; Hardy et al., 2012) and in other countries (Chinn & Rona, 2001; Ogden et al., 1994; Stamatakis, Primatesta, Chinn, Rona, & Falascheti, 2005; Wang et al., 2013), with some signs of levelling off (Hardy et al., 2012; Stamatakis, Wardle, & Cole, 2009). Overweight and obesity have been associated with poorer outcomes in later childhood, including reduced self-esteem and psychosocial well-being (Griffiths, Parsons, & Hill, 2010), and the development of cardiovascular risk factors and metabolic disorders (Lobstein, Baur, & Uauy, 2004). In adulthood, overweight and obesity have been linked to a range of negative outcomes, including cancer (Guh et al., 2009), cardiovascular disease (Guh et al., 2009), and reduced healthy life expectancy (Nagai et al., 2012; Steensma et al., 2013).

There is a paucity of research examining the association between overweight, obesity, and development in young children, and of the studies that are available, findings have been mixed. There is some evidence that obese children have poorer socio-emotional well-being and behavior (Cawley & Spiess, 2008; Drukker, Wojciechowski, Feron, Mengelers, & Van Os, 2009; Griffiths, Dezateux, & Hill, 2011; Sawyer et al., 2006), cognition and language (Cawley & Spiess, 2008; Kamijo et al., 2012), and academic scores (Cottrell, Northrup, & Wittberg, 2007). Obese children have also been shown to be at increased risk of asthma or wheezing (Wake et al., 2013; Wake, Hardy, Sawyer, & Carlin, 2008), poor scores on global measures of health (Wake et al., 2013), lower daily activity skills, and fine and gross motor abilities (Castetbon & Andreyeva, 2012; Cawley & Spiess, 2008; D'Hondt et al., 2013; Mond, Stich, Hay, Kraemer, & Baune, 2007). In many cases, these differences are small (Li, Dai, Jackson, & Zhang, 2008; Sawyer et al., 2006; Wake et al., 2013; Wake et al., 2008), and several studies show inconsistencies across outcomes, genders, or age groups (Jansen, Mensah, Clifford, Nicholson, & Wake, 2013; Jansen, Mensah, Clifford, & Tiemeier et al., 2013; Kamijo et al., 2012; Lawlor et al., 2005; Sawyer et al., 2006), or that the relationships are confounded by socio-economic circumstances (Datar, Sturm, & Magnabosco, 2004; Li et al., 2008). It has been postulated that null findings may be due to some studies examining overweight and obese children as one group (Griffiths et al., 2011). It is possible that any effect on child development may be more evident as the extent to which a child is overweight increases, and consequently, there is a need to examine overweight and obesity separately.

1.2. Thinness and Early Childhood Development

Recently, age- and gender-adjusted BMI cut-offs for thinness (low BMI) were created by Cole, Flegal, Nicholls, and Jackson (2007), to complement the International Obesity Taskforce (IOTF) cut-offs for childhood overweight and obesity (Cole, Bellizzi, Flegal, & Dietz, 2000). In high-income countries, much less attention has been paid to the determinants and consequences of childhood thinness than overweight and obesity, even though there is evidence that thinness remains a public health issue (Armstrong & Reilly, 2003; Boddy, Hackett, & Stratton, 2009; O'Dea & Amy, 2011; Wake et al., 2013). The majority of evidence refers to the impact of more chronic measures of impeded growth in early childhood (such as stunting) on development. Nevertheless, it is thought that moderate or mild degrees of thinness can impede development, including language, intelligence, attention, reasoning, and visuospatial functioning (Nyaradi, Li, Hickling, & Foster et al., 2013; Sandjaja et al., 2013). There is a dearth of research examining the association between thinness and child development in high-income countries, particularly in preschool children, and using measures of development that capture the preparedness of children to fully benefit from and participate in school life. The limited evidence base indicates that thinness is associated with worse academic scores (Cottrell et al., 2007), poorer global health (Wake et al., 2013; Wijga et al., 2010), higher special health care needs (e.g., having a chronic health condition; Wake et al., 2013), and possibly higher rates of infection and conditions which limit daily functioning (Wijga et al., 2010). On the other hand, studies have found that children who are thin are no different from healthy-weight children in terms of their behavior and socio-emotional well-being (Wake et al., 2013), susceptibility to respiratory infections, number of visits to general practitioners, school absenteeism due to illness (Wijga et al., 2010), and motor skills (Castetbon & Andreyeva, 2012). Indeed, one study found that thin children had a reduced risk of asthma (Wake et al., 2013), and another that thin children were less likely to display behavioral problems (Drukker et al., 2009), when compared with healthy-weight children. However, various definitions of thinness (or low BMI) were used in these studies, limiting comparability.

1.3. Nutrition and early child development

BMI is a widely acknowledged marker of malnutrition in population research (de Onis & Blössner, 2003). For example, thinness can occur when children do not have sufficient energy and protein (de Onis, Monteiro, Akré, & Glugston, 1993); and protein-energy malnutrition often goes hand-in-hand with other nutritional problems, such as deficiencies in micronutrients (Grantham-McGregor et al., 1999a). At the other end of the BMI spectrum, overweight and obesity reflect an excess of the energy needed for childhood growth and activity (de Onis & Blössner, 2003). Despite overconsumption of energy, obese individuals may still be lacking in some macro-nutrients (e.g., protein) and also micro-nutrients (such as iron) that are needed for healthy development (Burkhalter & Hillman, 2011; Tanumihardjo et al., 2007).

While our understanding of the relationship between nutrition and child development requires further advancement, there is some evidence that children who are deficient in macro-nutrients (such as protein) and micro-nutrients (such as iron and zinc), have poorer cognitive, behavioral, and motor development, as well as physical illness (Burkhalter & Hillman, 2011; Grantham-McGregor,